"*Graphephorum flexuosum*, only doubtfully referred to *Graphephorum* by Prof. Thurber, is neither one nor the other, but a good genus.

Graphephorum melicoides should be *Trisetum melicoides*, or if a genus (*Graphephorum*) be made for it, it should come next to *Trisetum* or *Avena*, for it is evidently Avenaceous."

The Fossil Flora of the Globe.[1]

BY LESTER F. WARD.

HISTORICAL VIEW.—The writers of antiquity make no mention of any form of vegetable petrification. The earliest allusion to the subject was made by Albertus Magnus in the thirteenth century. Agricola and Gesner treated of petrified wood in the sixteenth century. The first mention of any kind of vegetable impression in the rocks was made by Daniel Major, of Jena, in 1664. In 1699 Edward Lhwyd, of London, wrote an extensive treatise on such impressions. He maintained that they were the remains of plants that had perished in the Noachian deluge. In 1709 Scheuchzer, of Switzerland, defended this view in his "Herbarium Diluvianum," a large work, in which he described and figured many fossil plants, referring them to species living in Europe. In 1718 this author went so far as to classify the fossil plants according to the system of Tournefort. In 1723 he published a new edition of the "Herbarium Diluvianum," into which he introduced this classification, and enumerated 445 species. A powerful reaction against this method followed; comparisons with living plants were carefully made, which failed to establish the identity of the fossils. The idea of their exotic origin was thereupon suggested, and for a time prevailed, but towards the close of the eighteenth century this in turn gave way to the true view of the existence of the former geologic periods with floras of their own differing from that of the present. Baron von Schlotheim headed this new school, and was followed by Count Sternberg and Adolphe Brongniart, who jointly founded the science of vegetable paleontology in the first quarter of the present century.

The first attempt to place it upon the footing of a systematic

[1] Abstract, prepared by the author, of a paper read before the A. A. A. S., Philadelphia, 1884.

science was made by Rev. Henry Steinhauer, of Bethlehem, Pennsylvania, in a paper read before the American Philosophical Society, and published in its "Proceedings" for the year 1818. In this paper he described and figured ten species of Waller's genus *Phytolithus*, which was made to embrace nearly all forms of vegetable fossils. Two years later Schlotheim, in his "Petrefactenkunde" applied specific names to 78 fossil plants. Brongniart, in his "Prodrome," published in 1828, went much farther. He referred many fossil plants to living genera, and created a largen umber of new extinct genera. He enumerated 501 species, many of which were fully characterized and thoroughly illustrated in his "Histoire des Végétaux Fossiles."

A census of fossil plants was taken by Unger in 1845, which showed that the number of known species had increased to 1,648. In 1848 Göppert made a similar enumeration, and found 2,055 species. The extraordinary activity that followed in the developing of new fossil floras rendered it possible for Schimper, in 1874, to describe about 6,000 species in his great work, "Traité de Paléontologie Végétale." The decade which has elapsed since the appearance of that work has witnessed extensive investigations in this field, particularly in the arctic regions and in the United States, and the number of fossil species now known to science is probably between eight and nine thousand.

Geological View.—The most ancient vegetable remains known are two species of *Oldhamia* from the Cambrian of Ireland. From the Lower Silurian 44 species, chiefly marine algæ, have been named. Among these, however, are included the earliest terrestrial forms, viz., *Eopteris Morierei*, Sap., *Sphenophyllum primævum*, Lx., and two other vascular plants from the Cincinnati Group. Of the 13 species of the Upper Silurian, five are vascular plants, and these include *Cordaites Robbii*, Dawson, from Hérault. The Devonian furnish 188 species of fossil plants, in which ferns play the leading rôle, while from Permo Carboniferous strata nearly two thousand species are known. Only 67 species are found in the whole of the Trias. With the Rhetic a new impulse is felt increasing to the Oolite, in which 419 species occur. The Upper Jurassic and Lower Cretaceous are sparingly supplied with the remains of vegetation, but in the Cenomanian, to which the beds of Atane, Greenland, and our own Dakota Group of Kansas and Nebraska are referred, nearly 500 species of fossil plants have already been found. The Turonian, with its probable equivalent in the west, the Fort Benton Group, is

nearly destitute of vegetable remains, but the Senonian immediately overlying it, with which the Canadian geologists have correlated certain rich plant beds of British Columbia, and to which Heer's flora of Patoot, Greenland, must be referred, yields more than 350 species. The Laramie Group of the western United States is thought to be extreme Upper Cretaceous.' This is very rich in plants, and 333 species have already been described from this horizon.

The Tertiary flora is much more abundant than even that of the Carboniferous. The Eocene furnishes nearly 800 species (including our Green River Group and the Paleocene beds of Sezanne and Gelinden). The Oligocene of Europe yields a somewhat larger number. The maximum is attained in the Miocene, from which more than three thousand fossil plants are known. The Miocene practically closes the geological series so far as vegetable paleontology is concerned. Only about 150 Pleiocene species exist, and a still smaller number from the Quatenary.

BOTANICAL VIEW.—I. First appearance of types.

The Oldhamias of the Cambrian, mentioned in the last paper, are classed as marine algæ of the order *Florideæ*. The ferns, *Equisetineæ*, and *Lycopodineæ* all appeared in the Lower Silurian. One species of *Cordaites*, which is now regarded as the ancestral type of *Coniferæ*, occurs in the Upper Silurian. The *Rhizocarpeæ*, according to Dawson, existed in the Devonian of Canada and Brazil.

The *Cycadaceæ* and the Monocotyledons have their earliest known representatives in the Carboniferous. The order *Gnetaceæ* is represented, according to Heer, in the Oolite of Siberia by his species *Ephedrites antiquus*. The Dicotyledons first appear in the Urgonian of Kome, Greenland, through Heer's single species *Populus primæva*. All three of the divisions of dicotyledonous plants occur in great abundance in the Cenomanian. If the genus *Selaginella* is regarded as belonging to the *Ligulatæ*, this small transitional type also first appears in the Cenomanian, at Atane, Greenland.

All the leading types of vegetation are thus introduced without going later down the geological scale than the middle Cretaceous.

II. Age of maximum relative predominance of each type. The marine algæ, of course, being the only vegetation, were supreme during the Cambrian and early Silurian. The maximum relative predominance of each of the other principal types was reached as follows: The ferns in the Permian, the *Equiset-*

Number of Species of each of the Principal Types of Vegetation that have been present time, as nearly as it is possible to ascertain, together with the

		Geological Formations.	Cryptogams: Cellular. No.	Cellular. p. c.	Vascular. Ferns. No.	Ferns. p. c.	Rhizocarpeæ. No.	Rhizocarpeæ. p. c.	Equisetineæ. No.	Equisetineæ. p. c.	Lycopodineæ. No.	Lycopodineæ. p. c.	Ligulateæ. No.	Ligulateæ. p. c.
		Present time	35,000	23.89	3,000	2.05	100	0.07	30	0.02	500	0.34	400	0.27
Cenozoic.		Quaternary	27	33.3	4	4.9	......	......	2	2.5	......	......	......	......
Cenozoic.	Tertiary.	Amber	37	55.2	......	......	......	......	......	......	......	......	......	......
Cenozoic.	Tertiary.	Pliocene	......	......	3	3.1	......	......	......	......	......	......	......	......
Cenozoic.	Tertiary.	Miocene	138	5.5	87	2.9	6	0.2	18	0.6	......	......	2	0.06
Cenozoic.	Tertiary.	Oligocene	17	2.2	17	2.2	1	0.1	3	0.4	......	......	......	......
Cenozoic.	Tertiary.	Green River	5	2.2	8	3 5	2	0.9	3	1.3	1	0.4	1	0.4
Cenozoic.	Tertiary.	Eocene	71	10.3	22	3.2	......	......	1	0.2	......	......	......	......
Cenozoic.	Tertiary.	Paleocene	3	2.5	7	5.9	......	......	......	......	......	......	......	......
Mesozoic.	Cretaceous.	Laramie	13	3.9	23	6.9	1	0.3	4	1.3	1	0.3	3	0.9
Mesozoic.	Cretaceous.	Senonian	23	6.5	73	20.6	......	......	1	0.3	......	......	......	......
Mesozoic.	Cretaceous.	Turonian	1	20.0	1	20.0	......	......	......	......	......	......	......	......
Mesozoic.	Cretaceous.	Cenomanian	8	3.3	38	15.5	1	0.4	1	0.4	......	......	1	0.4
Mesozoic.	Cretaceous.	Dakota	1	0.5	7	3.3	......	......	......	......	......	......	......	......
Mesozoic.	Cretaceous.	Gault	......	......	10	27.8	......	......	......	......	......	......	......	......
Mesozoic.	Cretaceous.	Urgonian	......	......	50	46.3	1	0.9	3	2.8	1	0.9	......	......
Mesozoic.	Cretaceous.	Necomian	10	25.6	12	30.8	......	......	......	......	......	......	......	......
Mesozoic.	Jurassic.	Wealden	7	5.8	44	36.4	......	......	......	......	......	......	......	......
Mesozoic.	Jurassic.	Coral	19	29.2	12	18.4	......	......	......	......	......	......	......	......
Mesozoic.	Jurassic.	Oolite	39	9 3	133	31.7	1	0.3	14	3.3	3	0.7	......	......
Mesozoic.	Jurassic.	Lias	13	9.7	44	32.8	......	......	4	3.0	......	......	......	......
Mesozoic.	Jurassic.	Rhetic	8	6.3	69	54.3	......	......	5	3.9	......	......	......	......
Mesozoic.	Trias	Keuper	......	......	15	36.6	......	......	3	7.3	......	......	......	......
Mesozoic.	Trias	Muschelkalk	2	33.3	1	16.7	......	......	......	......	......	......	......	......
Mesozoic.	Trias	Bunter Sandstein	......	......	7	31.9	......	......	1	4 5	......	......	......	......
Paleozoic.		Permian	6	1.8	186	55.4	......	......	26	7.7	9	2.7	......	......
Paleozoic.		Carboniferous	17	1.2	627	42.4	......	......	143	9.7	368	24.9	......	......
Paleozoic.		Sub-carboniferous	5	3.7	64	47.4	1	0.8	20	14.8	25	18.5	......	......
Paleozoic.		Devonian	33	17.6	79	42.0	3	1.6	16	8.5	28	14.9	......	......
Paleozoic.		Upper Silurian	8	61.5	2	15.4	......	......	1	7.7	1	7.7	......	......
Paleozoic.		Lower Silurian	40	90.9	1	2.3	......	......	1	2.3	2	4.5	......	......
Paleozoic.		Cambrian	2	100.0	......	......	......	......	......	......	......	......	......	......

ineæ and the *Lycopodineæ* in the Carboniferous, the *Cycadaceæ* in the Lias or Oolite, the *Coniferæ* in the Wealden or Neocomian, the Monocotyledons in the Eocene, the monochlamydeous Dicotyledons in the Cenomanian, the polypetalous Dicotyledons in the Miocene, and the gamopetalous Dicotyledons in the present living flora of the globe.

III. Probable true period of origin and of maximum absolute development of each type.

found Fossil in each Geological Formation; also, the number existing at the percentage that each type forms of the total flora of each formation.

PHÆNOGAMS.														Total.
GYMNOSPERMS.						ANGIOSPERMS.								
Cycadeæ.		Coniferæ.		Gnetaceæ.		Monocotyledons		Dicotyledons.						
								Apetalæ.		Polypetalæ.		Gamopetalæ.		
No.	p. c.	No.	p. c.	No.	p. c.	No.	p. c.	No.	p. c.	No.	p. c.	No.	p. c.	
75	0.05	300	0.24	40	0.03	20,000	13.65	12,000	8.19	35,000	23.89	40,000	27.31	146,445
2	2.5	4	4.9	......	......	......	......	27	33.3	8	9.9	7	8.7	81
......	......	14	20.9	1	1.5	2	3.0	5	7.5	1	1.5	7	10.4	67
......	......	13	13.3	......	......	9	9.2	32	32.6	31	31.6	10	10.2	98
6	0.2	250	8.2	1	0.04	272	8.9	826	27.1	1,064	35.0	346	11.3	3,046
2	0.3	64	8.3	1	0.1	82	10.6	256	33.1	259	33.6	70	9.1	772
......	......	10	4.4	......	......	21	9.2	85	37.1	73	31.9	20	8.7	229
3	0.4	34	4.9	......	......	116	16.8	162	23.5	221	82.1	59	8.6	689
......	......	1	0.8	......	......	7	5.9	57	47.9	39	32.8	5	4.2	119
1	0.3	15	4.5	......	......	33	9.9	125	37.5	84	25.2	30	9.0	333
5	1.4	34	9.6	......	......	18	5.1	118	33.3	64	18.1	18	5.1	354
......	......	1	20.0	......	......	......	......	......	......	2	40.0	......	......	5
11	4.5	28	11.4	......	......	6	2.5	61	25.0	82	33.7	7	2.9	244
7	3.3	12	5.6	......	......	5	2.4	88	41.3	84	39.4	9	4.2	213
2	5.5	22	61.2	......	......	2	5.5	......	......	......	......	......	......	36
21	19.4	25	23.2	......	......	6	5.6	1	0.9	......	......	......	......	108
6	15.4	9	23.1	......	......	2	5.1	......	......	......	......	......	......	39
43	35.5	26	21.5	......	......	1	0.8	......	......	......	......	......	......	121
17	26.2	17	26.2	......	......	......	......	......	......	......	......	......	......	65
116	27.7	103	24.6	1	0.3	9	2.1	......	......	......	......	......	......	419
58	43.3	10	7.5	......	......	5	3.7	......	......	......	......	......	......	134
26	20.5	18	14.2	......	......	1	0.8	......	......	......	......	......	......	127
15	36.6	7	17.1	......	......	1	2.4	......	......	......	......	......	......	41
......	......	3	50.0	......	......	......	......	......	......	......	......	......	......	6
3	13.6	7	31.8	......	......	4	18.2	......	......	......	......	......	......	22
14	4.1	92	27.4	......	......	3	0.9	......	......	......	......	......	......	336
8	0.5	307	20.8	......	......	8	0.5	......	......	......	......	......	......	1,478
......	......	20	14.8	......	......	......	......	......	......	......	......	......	......	135
......	......	29	15.4	......	......	......	......	......	......	......	......	......	......	188
......	......	1	7.7	......	......	......	......	......	......	......	......	......	......	13
......	......	......	......	......	......	......	......	......	......	......	......	......	......	44
......	......	......	......	......	......	......	......	......	......	......	......	......	......	2

Cellular Cryptogams of some kind probably lived in the Laurentian, and account for the graphite beds and dark carbonaceous matter of certain Archæan rocks. Being an heterogeneous group their later representatives belonged to entirely different families. If we include the fungi the number of species is probably greater in the living flora than it was at any geological epoch. The ferns, *Equisetineæ*, and *Lycopodineæ* probably all originated in the Lower Silurian, and reached their absolute

maximum in the Carboniferous. The *Cycadaceæ* may have originated as early as the Devonian. They must have attained their absolute as well as their relative maximum development in the middle Jurassic. The *Coniferæ* through their archaic form, the *Cordaiteæ*, began in the Lower Silurian. They attained their full maturity in the Cretaceous, and are now on the decline. The Monocotyledons probably date back to the Lower Carboniferous or Devonian, and reached their highest expression in the palms whose reign occupied the early Tertiary. These also are probably now waning. The Dicotyledons must have had their real origin in the Lower Jura or Upper Trias; their absolute probably coincides with their relative development, the *Apetalæ* being now declining, the *Polypetalæ* about stationary, and the *Gamopetalæ* rapidly advancing.

GENERAL NOTES.

Results of the Philadelphia Meeting.—It is unnecessary to mention hose features which are obvious from the nature of the meeting and the large attendance of botanists. Not among the least results was the awakening to united action, which must be still further augmented in order to forward measures of commanding importance which are quite within the scope of the organization.

The action in reference to postage on botanical specimens seems to have been as vigorous and effective as could have been devised. The committee of the Club did their work well. The resolutions drawn up and presented by the officers of the Club to the Biological Section of the Association were as follows:

Resolved, 1st. That the Biological Section of the American Association for the Advancement of Science earnestly request that the Postmaster General recommend to Congress such changes in the existing postal laws as will permit the transmission through the mails of botanical specimens, accompanied with the customary written labels, giving name, locality, date of collection and collector's name, at fourth-class rates of postage.

Resolved, 2d. That he take such action as may be deemed best to secure similar regulations in the transmission of botanical specimens to and from Canada.

Resolved, 3d. That he cause the same subject to be presented before the Congress of the Universal Postal Union at its meeting in Lisbon in October next, in order, if possible, to secure like liberality with foreign countries.

The secretary of the Section was instructed to transmit the same to the to the Postmaster General. Upon the suggestion of the vice-president, Prof. Cope, a motion was carried to have a committee appointed to wait upon the Postmaster General, and personally urge the importance of the measures. The